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Prevalence of *Plasmodium falciparum* in Abs, Hajjah Governorate Northwest Yemen

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Abstract

Plasmodium falciparum malaria is the most common infection and endemic disease in Yemen. This study was carried out to determine the prevalence of *P. falciparum* malarial disease among patients in Abs region, Hajjah Governorate, Yemen from September 2013 to May 2014. Both thick and thin films were made and stained using Giemsa stain. Blood smears of 1528 cases out of 8434 individuals showed malarial parasites in their blood, the overall prevalence percentage was 18.1%. Male subjects were more infected (18.17%) compared to females (18.04%). Incidence of *falciparum* malaria was higher in winter in comparison to other seasons. The infection mostly occurred in age groups of five to fourteen years old. Regarding the symptoms, patients showed fever (100%), followed by chills (89.8%), headache (85.4%) and vomiting (54.7%). Lack of health care in rural regions of study area in addition to delay of treatment had an impact on the further injury and increase the clinical symptoms associated with disease.

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Introduction

Malaria is a disease caused by an intracellular Apicomplexa parasite of the genus *Plasmodium* and is transmitted by a bite of an infected female mosquito of the Anopheles species (Roetynck *et al*., 2006). Malaria is still one of the most prevalent infectious diseases in the world, affecting 198 million individuals per year and causing an estimated 584,000 subsequent deaths (WHO, 2014). There are five *Plasmodium* species, *P. falciparum*, *P. vivax*, *P. malariae, P. ovale,* and *P. knowlesii* (Singh *et al*., 2004; Collins, 2012), which cause human malaria. *P. falciparum* and *P. vivax are* the two predominant species responsible for most malaria infection (WHO, 2011).

Malarial infection is the most prevalent communicable disease in Yemen, with 81% of the country's landmass classified as endemic malaria (WHO, 2010). *P. falciparum* is the predominant species in Yemen where it is responsible for more than 90% of the malaria cases, with only minimal cases caused by *P. vivax* (Abdulsalam *et al*., 2010). Malaria persists as a major health problem in the Hajjah governorate especially Tehama region like Abs district northwest of Yemen.

Moreover the prevalence of human malaria varies from one governorate to other apparently reflecting climatic differences. According to annual report (NMCP, 2009), *P. falciparum* is predominant in Hajjah Governorate. The incidence of *P. falciparum* in 2009 was 4706 out of 4751 representing 99% of all infected cases; only 45 cases were *P. vivax*.

The transmission of *Plasmodium* species which is responsible for human malaria is affected by several demographic, socio–economic and genetic determinants addition to some factor such as temperature and rainfall. Also there are other factors like level of education, genotype, level of acquired immunity, housing conditions, and level of resistance to antimalarial drugs may all affect the chances of developing symptomatic malaria (Incardona *et al*., 2007; Al-Taiar *et al*., 2009).

The National Control Malaria Program (NCMP) in Yemen, is proactive in combating malaria through the implementation of several interventions that include distribution of insecticide-treated mosquito nets (ITNs), indoor residual spraying (IRS), proper diagnosis, proper treatment, and reactive and proactive case surveillance., Previous studies showed high prevalence of malaria in Yemen with mortality rates ranging from 2.1 – 4.7% in children (Alkadi *et al*., 2006; Al-Taiar *et al*., 2006).

The major symptoms of malaria are fever, malaise, headache, chills and sweats more over it can be present in the body systems as a respiratory and gastro-intestinal (Anstey *et al*., 2002).

Although Yemen has been classified as being in the control phase, the 2013 World Malaria Report stated that the data (collected in 2011) on which the report is based were insufficient to estimate the trend of malaria case incidence. By contrast, Saudi Arabia, the northern neighboring country of Yemen, showed more than 75% reduction in malaria case incidences placing it in the elimination phase, and Oman, the eastern neighboring country of Yemen is now in the prevention of re-introduction phase (WHO, 2011; WHO, 2012).

Abs one of the districts of the Tihama in Hajjah Governorate, Yemen and it is one of the highly endemic areas for malaria. No adequate information has yet been available in this area, because malaria infections are not studied systematically. Therefore the present study was designed for the first time with the aims of determining the prevalence and magnitude of malaria in Abs district. In addition to its relation to clinical manifestation and seasonal diversity with identify high risk localities and seasons of malaria.

Materials and methods

Study area

The study area was included six of the region of Abs district (Tehama) in Hajjah Governorate, which is located northwest of Sanaa capital of Yemen at distance of about 127 km.

It is overlooking the Red Sea in northwestern Hajjah province, the population of the this Governorate represent as 7.5% of the total population of Yemen, and occupies the fifth place among the governorates of the Republic in terms of population, and the number of directorates 31 Directorate, and the city center of the province's argument, and the most important cities Abs and Harad. The agriculture, grazing activity of the population and commercial activity as a border area with Saudi Arabia, the area has been highly endemic for malaria. The climate in Abs districts falls within coastal areas climate, hot in summer and temperate in winter.

Fig. 1. Location map of the study area, Abs area in Hajjah Governorate-Yemen.

Study population

Random sampling design was employed as the sampling method to demonstrate clinical parameter within epidemiological feature of malaria at Center of Malaria in Abs area, Hajjah Governorate northwest Yemen (Fig 1), health centers and Malaria Control Program- Hajjah, Yemen from September 2013 to May 2014. Also random samples were collected from children school and houses.

The total numbers of individuals surveyed were 8434; aged 8 month up to 75 years old including both males and females. Individuals surveyed were diagnosed by thin and thick blood smears which examined microscopically after Giemsa staining. Patient's selection was done by simple random sampling including males and females whom infected with *P. falciparum* malaria, and with a history of fever, headaches, loss of appetite, joint pains, vomiting and malaise for a period of 4-20 days. Percentages of infection were calculated.

Data analysis

Data was entered into program of Microsoft Excel and descriptive statistic was applied to indicate the prevalence of *P. falciparum* with its relation to sex , age and seasons which expressed as percentage. Also data was analyzed using Statistical Package for Social Science (SPSS), Windows version 21. P value of less than 0.05 was considered as statistically significant.

Ethical considerations

Ethical approval was given by the Hospital Management and Center of Malaria in Abs area.

Results

In the current study, 1528 out of 8434 Yemeni individuals showed malarial parasites. The overall positive percentage of *P. falciparum* malaria was 18.1% (Tab. 1).

Table 1. Prevalence of *Plasmodium falciparum* in Abs district Hajjah, Yemen.

Slides examined		
No. of cases	No. of positive	Positive %
8434	1528	18.1

The percentage of infection in the various localities in Abs- Hajjah province, Yemen was recorded. The high positive percentage of infection (20.8%) was recorded in Abs center followed by Badah-Bani hassan (19.1%). The low positive percentage of infection (10%) was recorded in villages Algar. While the positive percentage of infection in regions (Labadah, Rabou-Matwala and Albataria) were (17.7%, 14.2% and 12.9%) respectively (Tab. 2).

Table 2. *P. falciparum* malaria infection according to localities**.**

S. No.	Localities	Slides examined		
		No. of cases	No. of positive	Positive %
1	Center of Abs	3529	735	20.8
2	Badah	1970	376	19.1
3	Labada	1006	178	17.7
4	Rabou- Matwal	543	77	14.2
5	Algar	530	53	10
6	Al bataria	856	109	12.7
Total		8434	1528	18.1

The present results showed that the highest percentage of *falciparum* malaria infection was among males (18.17%) more than female (18.04%). However the differences was not statistically significant (p>0.05) (Tab. 3and fig. 2).

Regarding the percentage of *falciparum* malarial infection according to age group, the highest percentage was recorded (36.71%) among (5-14) age group followed by (30.56%) among age group less 5 years, then (26.32%) among age group (15-35). Greatest *P. falciparum* malaria prevalence was seen in both age groups (<5 and 5-14) years were (67.27%). The lowest percentage was recorded (6.6%) in those aged more than 30 years (Tab. 4). The differences between age group was statistically significant (p>0.0001).

Table 3. Percentage of *P. falciparum* malaria according to sex.

Sex	Slides examined	Slides positive (%)	positive (%)
Male	5092	925	18.17
Female	3342	603	18.04
Total	8434	1528	100

Highest percentage of infection was recorded in February (28%) followed by January (24.5%), statistically there is significant difference between months (P<0.05). It is clearly indicated that the percentage of infection increased in winter months (Tab.5 and fig. 3).

There was fluctuation in the distribution of infection in different months. The differences among seasons was statistically significant (p>0.002).

Regarding education, out of these 254 patients, the majority of them, 92 (36.2%) was comprised of those with primary school education while 80 (31.5%) reported to have attained Illiterate followed by semi-educated 54 (21.3%), then secondary education 17 (6.7), and the rest with college education 11(4.3%) (Tab. 6).

Tab. (7) and Fig. (4) Shows clinical symptoms of *P. falciparum* malarial patients. The most common symptom was fever 254 (100%) followed by chills 228

(89.8%) and headache 217 (85.4). Regarding other symptoms 139 (54.7%) of the malaria cases has vomiting, while 126 (44%) had Joint ache 112 (49.6%). Other features observed were reduced appetite 92 (36.2%), Diarrhea 61 (24%), sweeting 40 (15.7%) and Dizziness 35 (13.8%). Fig (5) a thick blood smear showing ring stage (R) of *P. falciparum*. Fig. (6) A thin blood smear showing ring forms and male gametocyte of *P. falciparum*, while (Fig. 7) shows ring forms and female gametocyte of *P. falciparum* in thick blood film. Fig. (8), shows schizont and ring forms of *P. falciparum* in thick blood film.

Table 4. Percentage of *P. falciparum* malarial patients according to age groups.

Age (Years)	NO. of positive	Over all infection %
5<	467	30.56
5-14	561	36.71
15-35	402	26.32
35 up to75	98	6.6
Total	1528	100

*P< 0.0001.

Discussion

Malaria remains a significant health problem in Yemen. Among the four species of *Plasmodium*. *P. falciparum* is the most prevalent and can be life threatening because of its severe complications. WHO reported that 75% of rural area population in Yemen does not have easy access to local health services. The poorest nations generally have the least resources for adequate control efforts (WHO, 2009).

Table 5. Prevalence of *P. falciparum* malaria parasite according to seasons.

Period of study	No. of examined	No. of positive	Positive%
September	228	11	4.3
October	233	16	6.9
November	805	56	7
December	1154	185	16
January	1695	416	24.5
February	1943	545	28
March	1311	204	17.1
April	896	93	15.6
May	69	2	2.9

P< 0.002.

In the present study, the presence of ring forms, trophozoites, schizont and gametocyte of *P. falciparum* indicate positive results. According to the present results, the overall prevalence of malaria in Abs districts in Hajjah Governorate was18.1%.Similar results have been reported in Taiz, governorate, Yemen which showed 18.6% (Alkadi *et al*., 2006), while this was higher than that of other research in Taiz, Governorate, Yemen which showed 14.1% (Abed *et al*., 2003). Other studies in other parts of Yemen recorded low positive rate ranging between 12.8% and 16.2% (Al-Taiar *et al*., 2006; Al-Maktari *et al*., 2003). Also the present data was higher than that of Indonesia (Syafruddin *et al*., 2009), Bangladesh (Haque *et al*., 2009) and Kenya (Imbahale *et al*., 2010).

Atif *et al.* (2009) reported an incidence rate of 10.5% malaria infection in a similar study among 1000 patients in Hyderabad, Sind, Pakistan. Our result also differed from the overall prevalence of 6.5% in adults and 5% in children reported in a study by Nkoghe *et al.* (2011) in rural Gabonese populations. Epidi *et al.* (2008) reported that the overall prevalence of 51.5% among blood donors in Abakaliki, Southwestern Nigeria.

Table 6. Educational characteristics of the *P. falciparum* malarial patients.

Educational level N=254	Frequency	Percentage %
Illiterate	80	31.5
Semi-Educated	54	21.3
Primary	92	36.2
Secondary	17	6.7
collage	11	4.3

Percentage of infection was different in the various localities in Abs region. Highest percentage of infection was in Center of Abs in comparison to other regions, then Badah and Labada. Despite the similarity in type of climate (Temperature and humidity) in all regions among Abs , but the center of Abs found to have the largest percentage being a meeting place for many visitors from many neighboring rural areas, where centers of health and hospitals scanty and rare. It is much less than that reported in some rural areas in Yemen (Bassiouny and Al-Maktari, 2009, Al-Taiar *et al.*, 2009). Several factors play important roles in the endemicity of malaria in the study area such as environmental factors like temperature and humidity.

Table 7. Clinical profile of symptoms in *P. falciparum* malarial patients.

Symptom	No. of patients N=254	Percent %
Fever	254	100
Chills	228	89.8
Headache	217	85.4
Vomiting	139	54.7
Join ache	126	49.6
Reduced appetite	92	36.2
Diarrhea	61	24
Sweeting	40	15.7
Dizziness	35	13.8

All of the cases reported in this study are due to *P. falciparum* (100%). Other incidence researches in Yemen (Bassiouny and Al-Maktari, 2005; Al-mekhlafi *et al.*, 2011) showed that major infection of malaria was due to *P. falciparum* malaria.

The infection with *P. falciparum* in examined cases was detected in both sexes. The present study revealed that males were more infected (60.54%) than females (39.46%). Similar results have been reported in Yemen (Al-Taiar *et al.*, 2006), Saudi Arabia (Malik *et al.*, 1998). Our results also agreed with Atif *et al.* (2009), who reported infection rate to be higher among young adult males in Pakistan. But differed from (Ibekwe *et al.*, 2009) in similar studies in South-eastern, Nigeria.

The increase of males' patients in our study can be due to more going out from houses; hence they have more chances of being bitten by infected mosquitoes. But this finding contrast with the results of Ibekwe *et al.* (2009) in studies in Southeastern Nigeria, who reported infection rate to be higher among females.

Moreover higher prevalence was seen among 5-14 age groups. This is consistent with the findings reported Houngbedji *et al.* (2015), whom reported that Children aged 11–16 years showed slightly higher *P. falciparum* prevalence compared to their younger counterparts, but the difference lacked statistical significance. Several previous results from Yemen and other countries reported that the highest prevalence in children between 1-10 years (Snow *et al.*, 2005), and differed from the finding reported in Kersa Woreda, Jimma (Haque *et al.*, 2009), which showed higher prevalence was seen among 11-40 years. This might be due to great exposure to the mosquito vectors among 5-14 age groups.

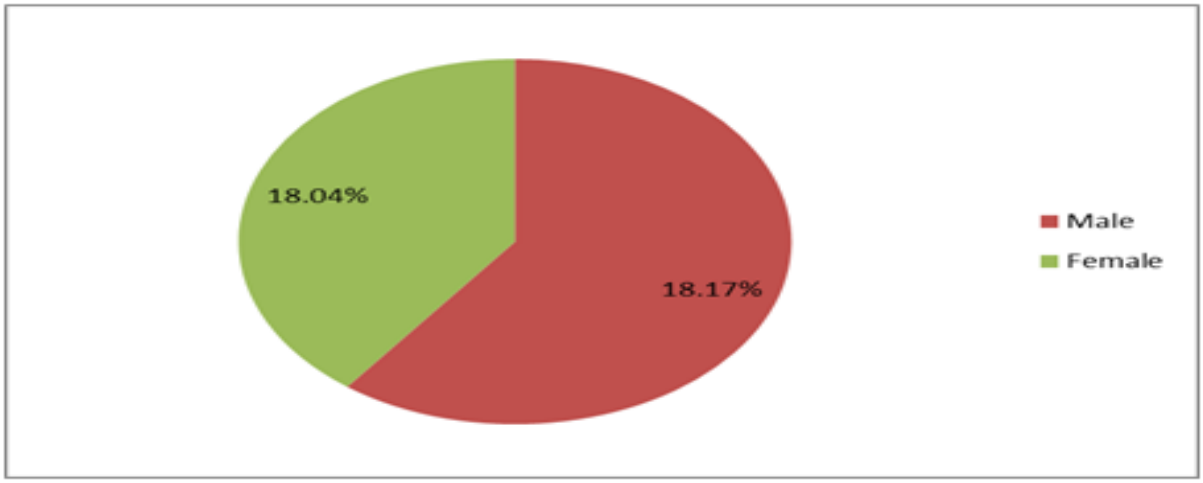

Fig. 2. Male to female ratio of *P. falciparum* malaria patients**.**

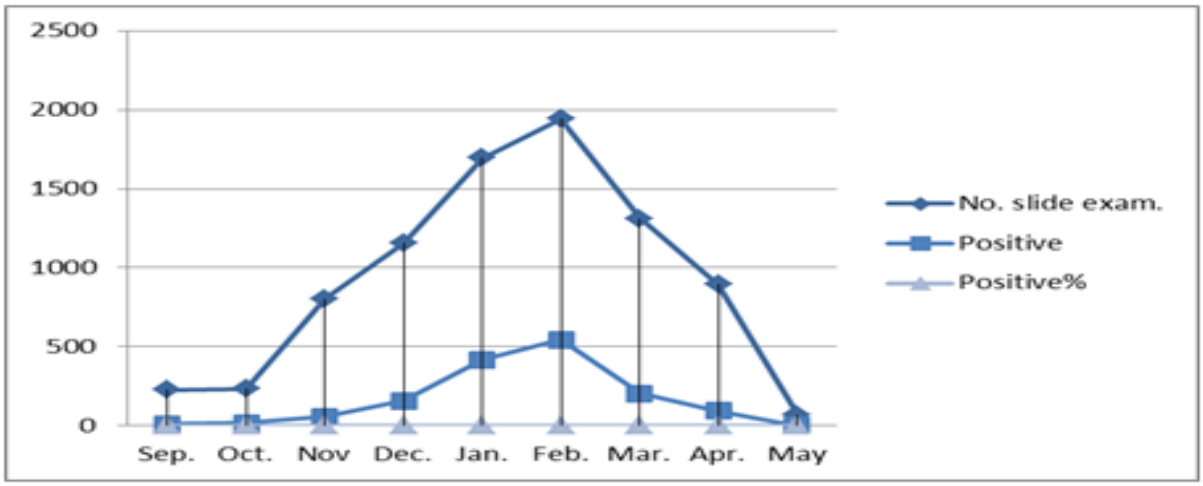

Fig. 3. Prevalence *P. falciparum* malaria and seasonal variation**.**

Severe malaria peak in young age group in Yemen has also been reported previously (Al-Taiar *et al.*, 2006), while in a recent systematic review which included data from Sub-Saharan Africa in the period 1980-2005, showed that hospital admissions for malaria involved mainly children < 5 years old (Carneiro *et al.*, 2010).

The seasonal variation in malaria parasite prevalence in districts of Abs can be attributed to changes in Anopheles abundance during the year; also the seasonality of climate greatly influences the transmission of malaria. Thomson *et al.* (2005), reported that the seasonality of climate greatly influences the seasonality of malaria.

In the present study the majority of seasonal parasite was recorded in February (28%) then January. The climate in Yemen differs depending on the region. In the coastal areas, the tropical monsoon in the summer, with two rainy seasons (February–April and July–September) and a mean temperature of 37•5°C, is replaced by dry, cooler weather, with a mean temperature of 24•0°C, in the winter. Relative humidity in such areas ranges between 70% and 90% and mean annual rainfall is about 200 mm (Al-mekhlafi *et al.*, 2011).

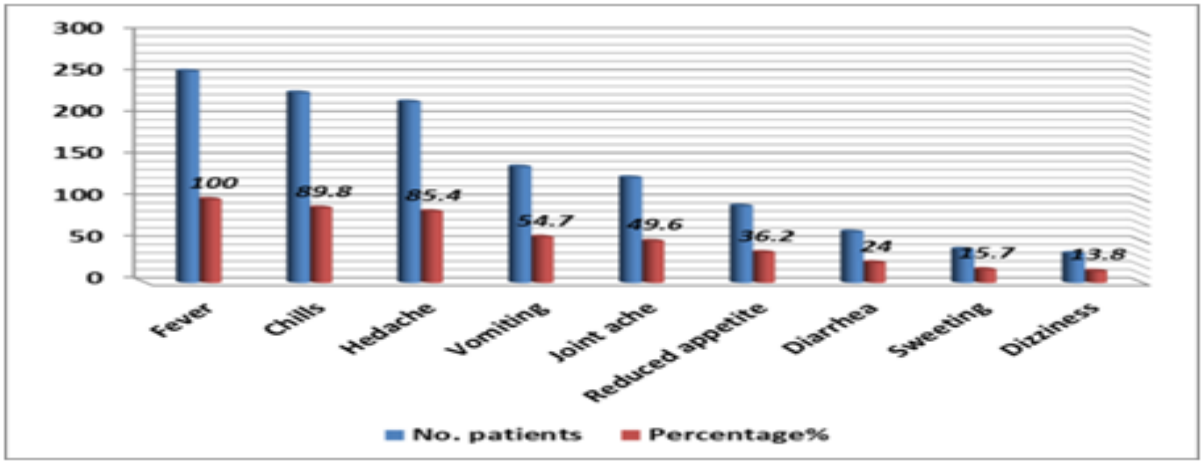

Fig. 4. Frequency of symptoms in patients with *P. falciparum* malaria.

On other hand, increased malaria risk was associated with various socio-demographic and behavioral factors. Educational level and some socio-demographic such as occupation, residence place, marital status and source of water supply considered in this study were associated with the intensity of *falciparum* malaria infection. In the current study, the infection rate decreased as educational level increased. High educational level was associated with malaria knowledge. This finding was in agreement with the study done in Assosa and Tigray regions of Ethiopia (Legesse *et al.*, 2007).

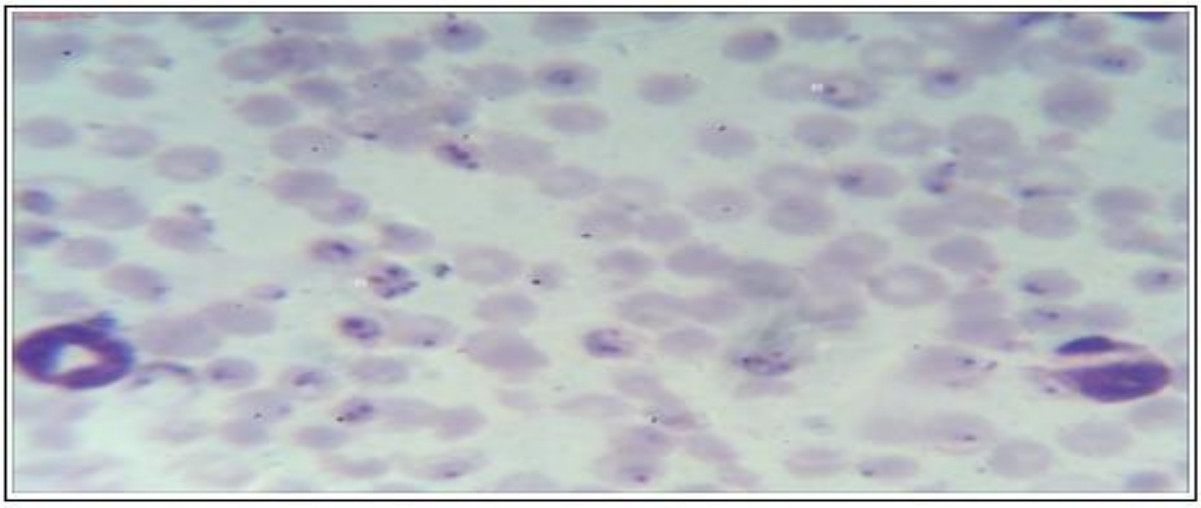

Fig. 5. Thick blood film showing ring stag of *P. falciparum*. Note the multiplicity of rings within the red blood cells.

This similarity may be explained by the fact that educated communities had better access to multiple source of information such as magazines, radio, and television and from their school education.

Also in this study the Illiterate and education level of primary school was extrusive associated with malaria risk. This finding supported by a study that was done in Kenya, by (Bloland *et al.*, 1999),

that the majority of caretakers in the study had <8 years education, which was predictive factor of parasitaemia. Al-Maaktari (1995) found that the occurrence of infection was the highest 84.3% among students who belonged to illiterate, read and write fathers followed by those who belonged to basic education 14.4%, consequently, the highest percentage of infection was 97.6% who belonged to illiterate, read and write mothers. While, Ropert *et al.* (2000) recorded that there was no relationship between malaria incidence and level of education attained by adults, when analyzed by number of years of school completed or by categories of highest level of educational institution attended.

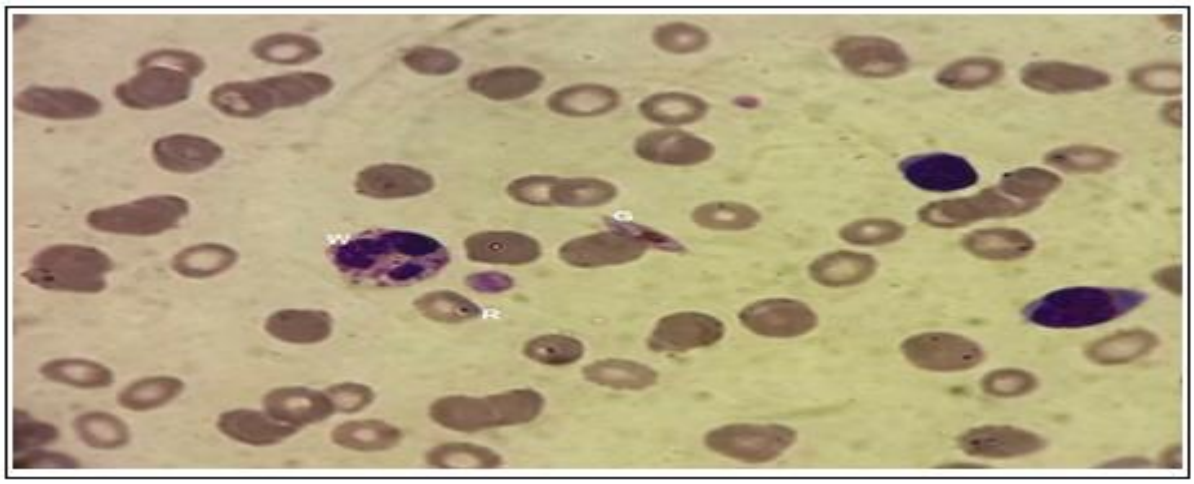

Fig. 6. Thin blood film showing ring stag(R) and male gametocyte (G) of *P. falciparum* malaria X100. Notice (W) the white blood cell.

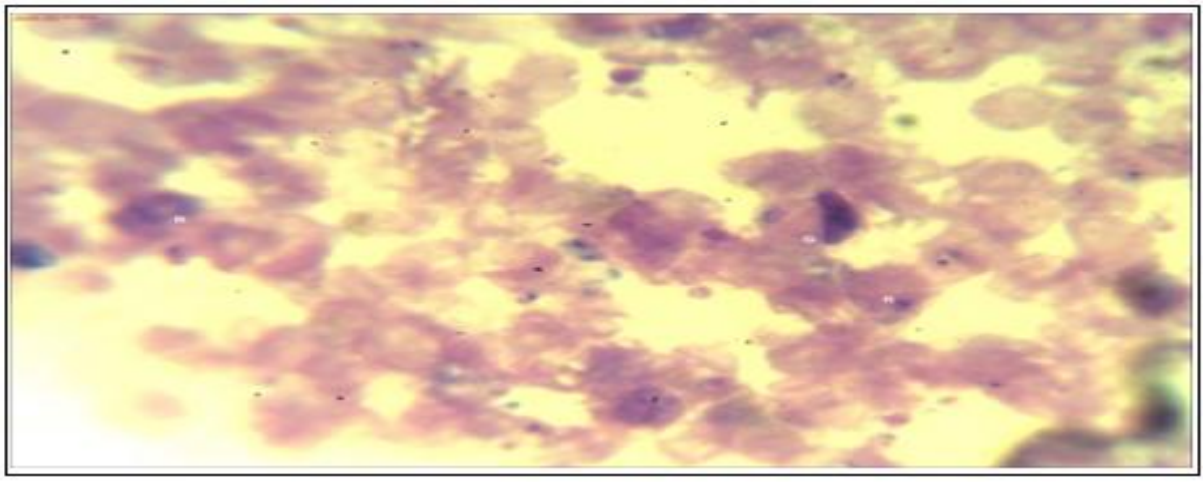

Fig. 7. Thick blood film showing ring stag(R) and female gametocyte (G) of *P. falciparum* malaria X100.

Malaria symptoms in endemic areas are affected by several factors such as host immunity and socio-cultural condition. Describing the prevalence of malaria symptoms and educational level provides better understanding of the local epidemiology of malaria in the population. Fever was observed in 100%, chills were observed in 89.8% and headache was recorded in 85.4%, vomiting was noted in 54.7% and Joint ache was observed in 49.6%.

Almost similar clinical patterns for most of the above parameters were observed in severe malaria. This differed from study conducted in India by Kashinkunti and Alevoor. (2014), they reported that vomiting was seen in 21% of the cases, headache was 36%, but agree with it in respect to fever where the previous study reported that the fever was noted in 94%. While Rasheed *et al.* (2009), mentioned that fever,

chills and sweating were the leading clinical in almost 91% of subjects with *P. falciparum*. Cycling of the asexual forms of the parasite within RBCs is responsible for the clinical symptoms of the disease, which range from uncomplicated fevers to life-threatening cerebral and placental malaria (Miller *et al*., 2002)

In study done by Choge *et al.* (2014), in Kenya showed a fever in 92.4%, high temperature in 97.5, sweating 92.3, shivering in 92.2, vomiting in 90%, severe headache in 99% of cases, which differs from our study which reported increase of rate fever, while decrease of headaches, vomiting and sweating among *falciparum* malaria cases of the present study.

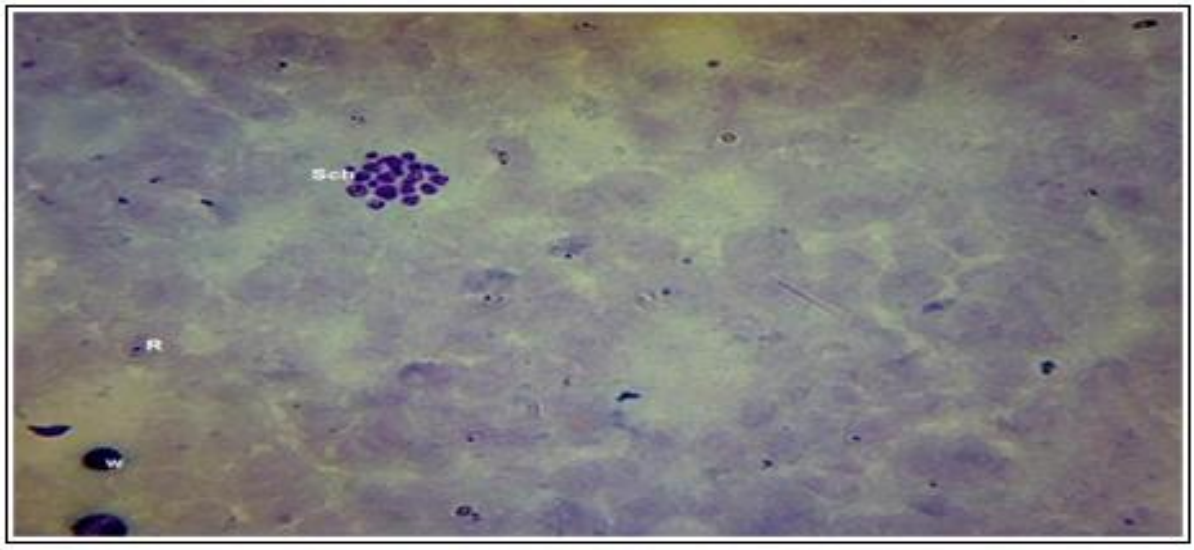

Fig. 8. Thick blood film showing ring stage and schizont (Sch) of *P. falciparum* malaria X100. Notice (W) the white blood cell.

In conclusion: Malaria remains a significant public health problem in Yemen. This study proved the occurrence of high prevalence of *P. falciparum* malaria among patients in Abs region. Malaria infection was more common in males than females, and younger age group was the more sufferers due to *falciparum*. *P. falciparum* carriage remains continual among patients.

More efforts therefore, needed by local health sector and any concerned bodies should collaborate to increase the knowledge as to how transmission of this parasite is prevented specifically in rural areas.

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Conflict of Interest

The authors declare no conflicts of interest.

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